Adaptive Nitrogen Management for Maize Using Climate Data and Model Simulations

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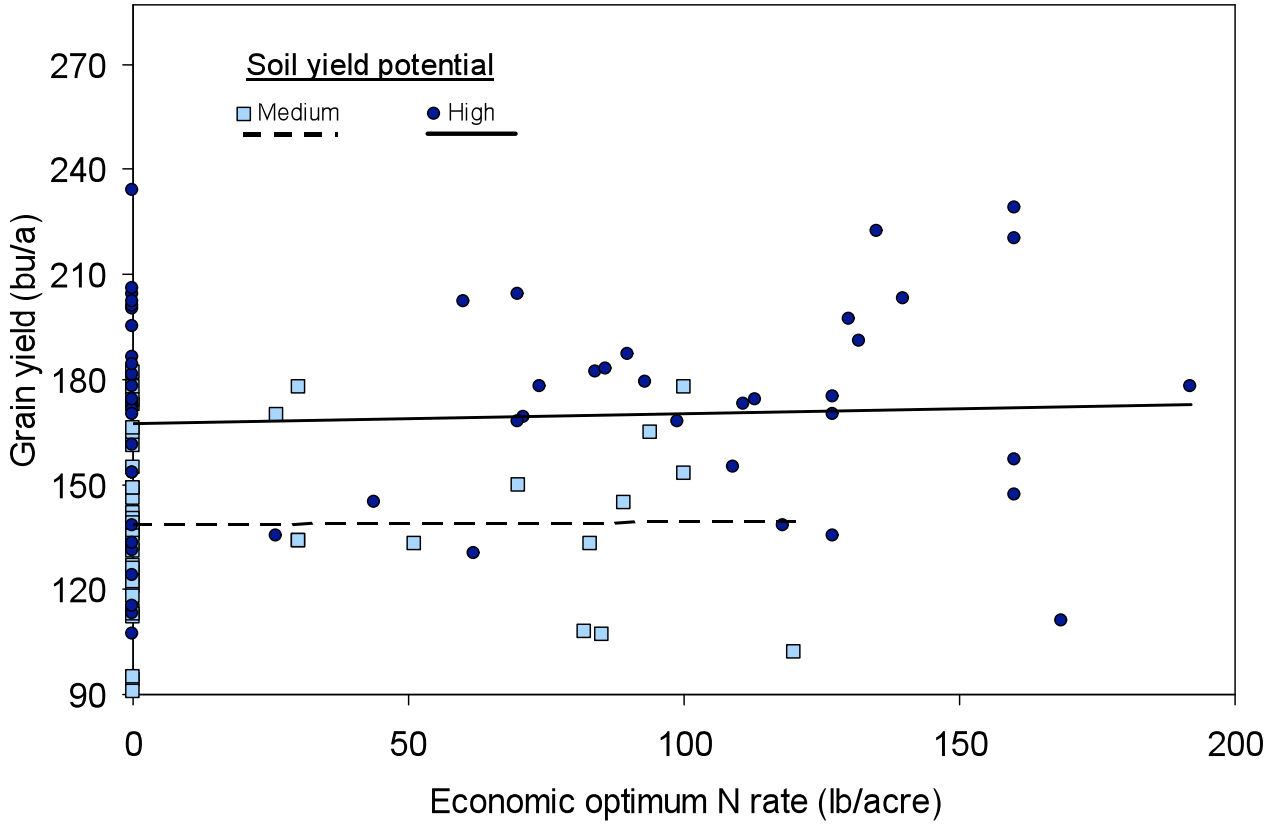
College of Agriculture and Life Sciences
Department of Crop and Soil Sciences

Estimating Economic Optimum N Rates: Static Approaches

1. Mass-Balance Approach:

Generally based on a yield goal and associated N uptake, minus credits given for non-fertilizer N sources such as mineralized N from soil organic matter (SOM), preceding crops, and organic amendments.

Variability in Economic Optimum N Rate
(from Bundy)



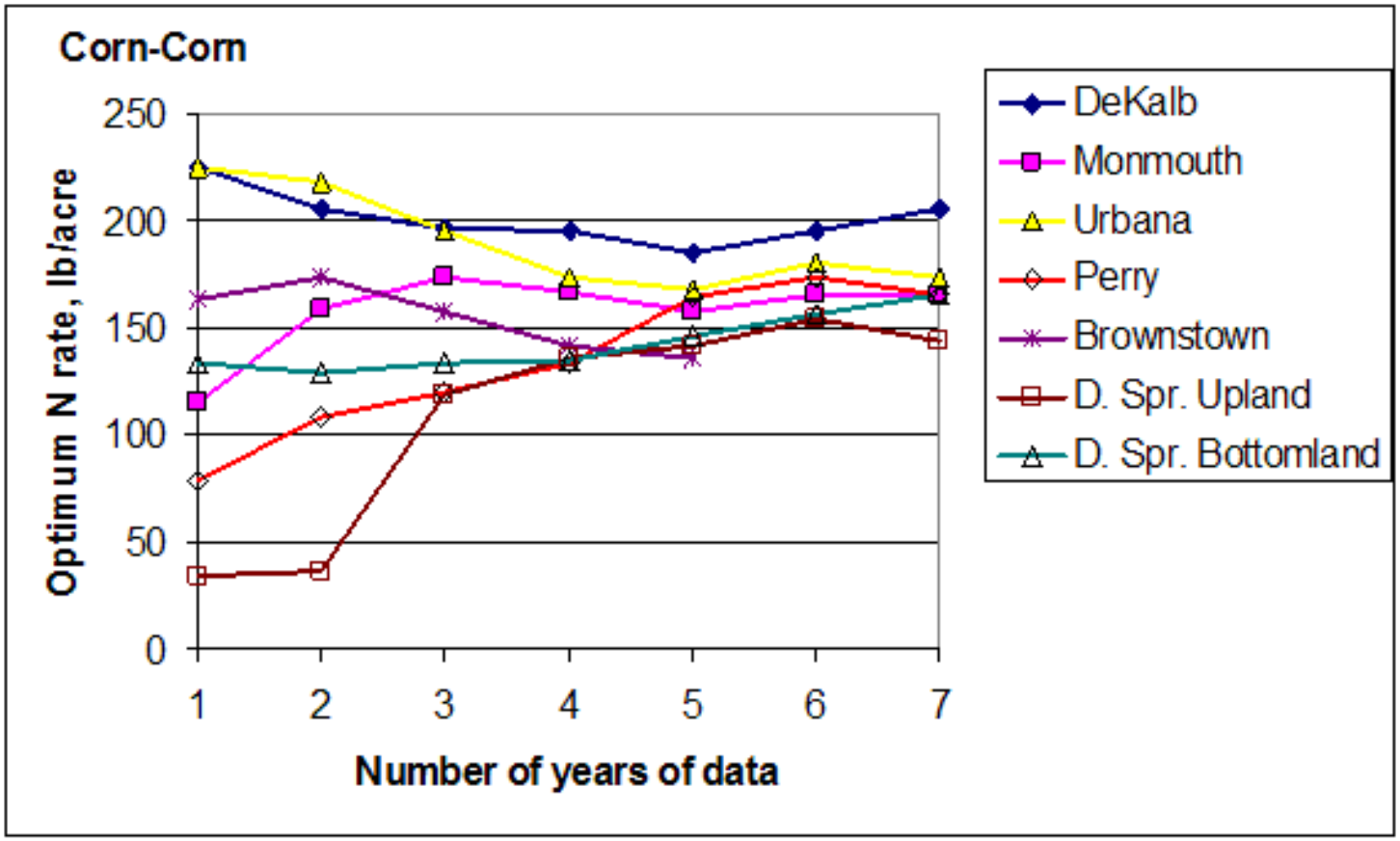
Estimating Economic Optimum N Rates

Static Approaches

2. Maximum Return to N (MRTN) Approach

- Based on extensive multi-year and multi-location field trials, curve-fitting, and economic analyses.
- The rate with the largest average net return over many years is the MRTN
- Adjustments based on yield expectations and price ratios are sometimes considered.
- Now used in the major cornbelt states.

Illinois trials (Nafziger, 2006)



The Need for Adaptive N Management

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EDF-NRCS 14 AUG 2008

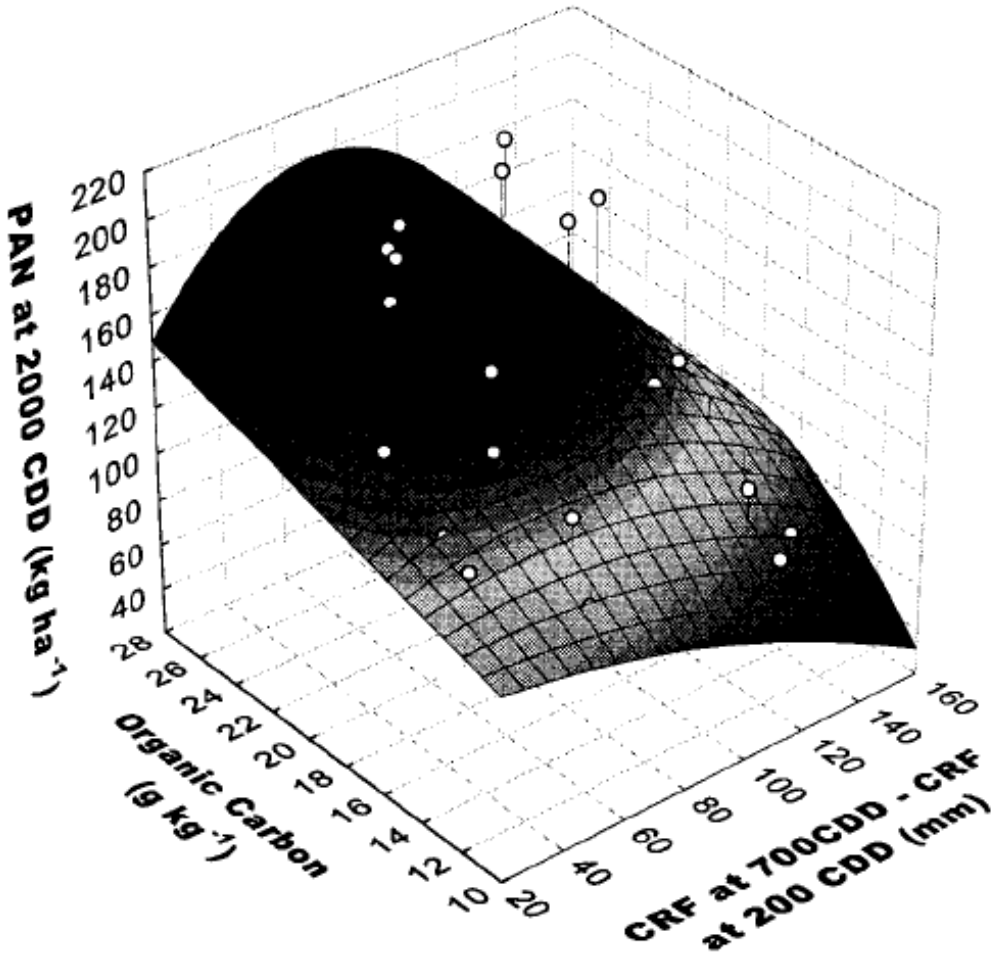
Variance component analysis for economic optimum N rates w/i a field

(5 years x 3 soil types, New York)

Source	Variance Component $kg^2\ ha^{-2}$	Range (4σ) $kg\ ha^{-1}$
Year	501	90
Soil Type	0	0
Year*Soil Type	73	34

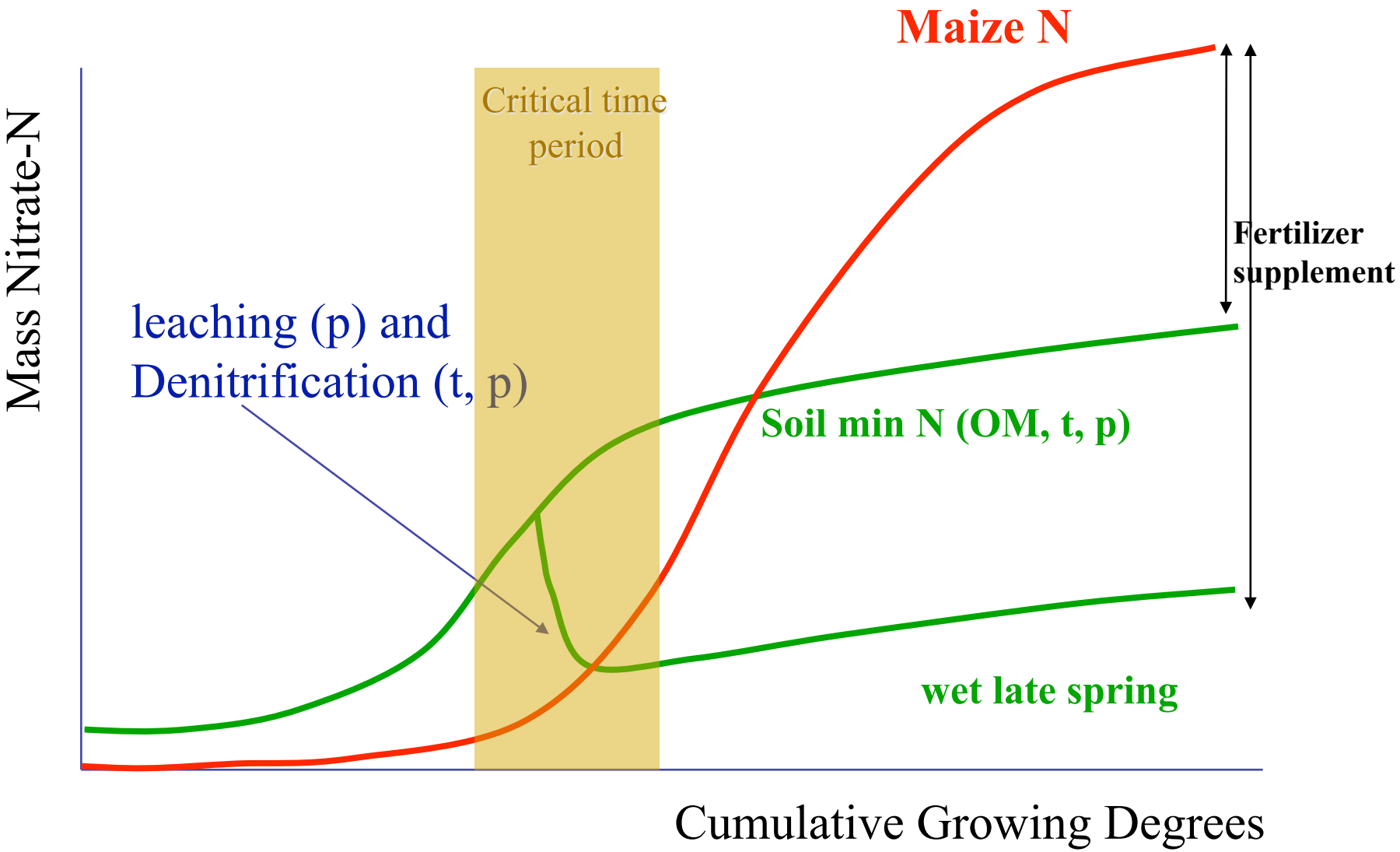
Sogbedji, J.M., H.M. van Es, S.D. Klausner, D.R. Bouldin, and W.J. Cox. 2001. Spatial and temporal processes affecting nitrogen availability at the landscape scale. Soil & Tillage. Research 58 (3-4) 233-244.

Plant Available N Depends on Soil Organic Matter and Rainfall
(Elora, Ontario)

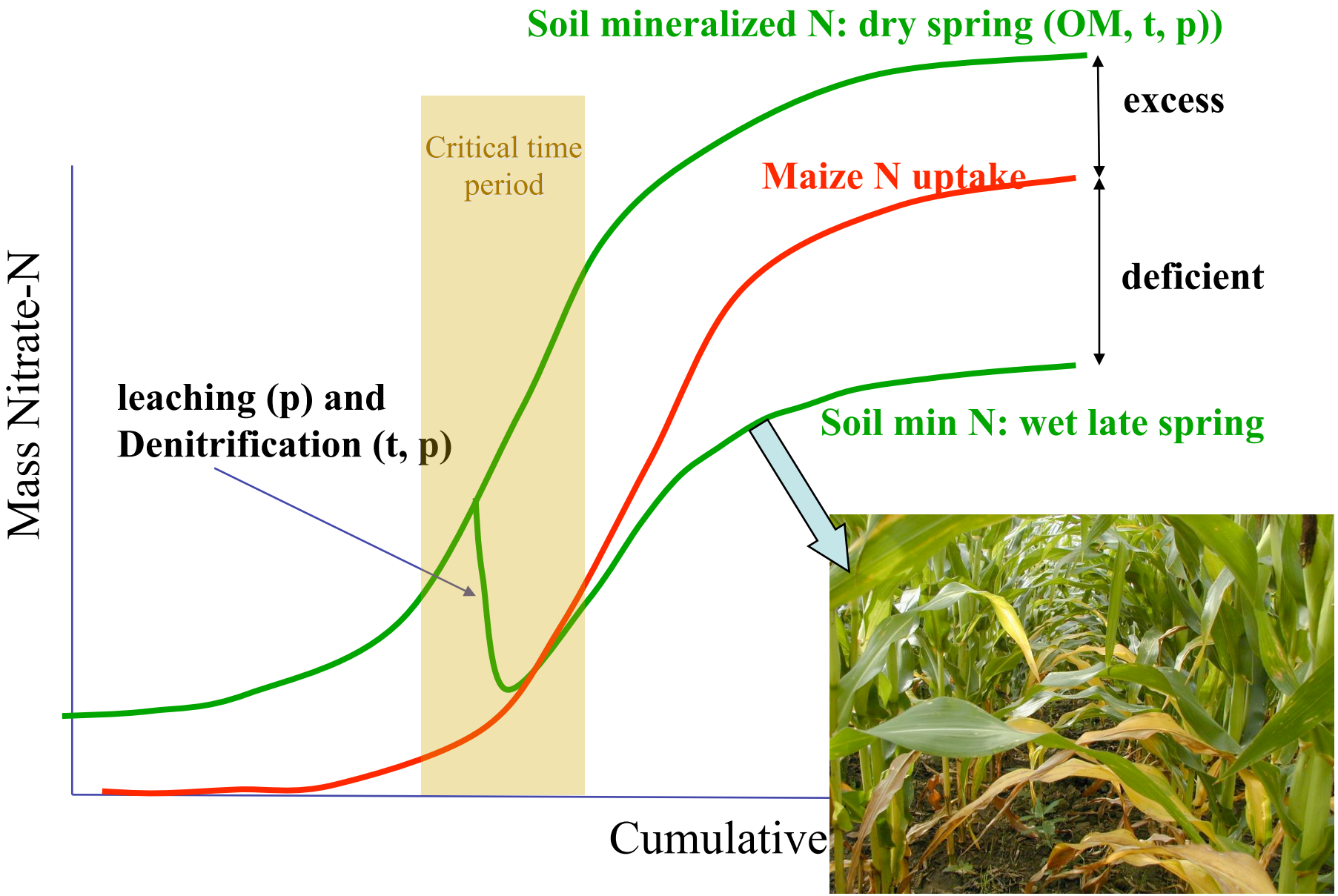


Kay, B.D., A. A. Mahboubi, E. G. Beauchamp, and R. S. Dharmakeerthi. 2006. Integrating Soil and Weather Data to Describe Variability in Plant Available Nitrogen. Soil Sci. Soc. Am. J. 70:1210–1221.

Soil Nitrate from SOM and Corn N Uptake



Soil Nitrate from SOM+Manure and Corn N Uptake



Estimating Economic Optimum N Rates
Adaptive Approaches

- **Pre-Plant Soil Tests**
  - Pre-Plant NO3/NH4 Test (PPNT)
  - Illinois Soil Nitrogen Test (ISNT)

Address organic matter variability, but do not incorporate early-season weather effects

- **In-Season Soil Tests**
  - PSNT / LSNT

Incorporate organic matter and early-season weather effects, but are imprecise without weather interpretation

Estimating Economic Optimum N Rates
Adaptive Approaches

- **Leaf or Canopy Sensing:**
  - Leaf chlorophyll (Sawyer et al., 2006)
  - multi-band aerial/satellite or on-the-go sensing (e.g., Sripada et al.,2005; Hong et al., 2006; Scharf et al., 2007).

Adapt – N Infrastructure

Precision Nitrogen Management (PNM) model: the core of the Adapt-N tool

Combines two models:

- Soil processes model (LEACHN, Hutson, 2003)

- Crop growth/N uptake model (Sinclair and Muchow, 1993)

LEACHN / PNM Model Calibrations and Validations

Fertilizer and Sod Incorporation

- Sogbedji, J.M., H.M. van Es, J.L. Hutson, and L.D. Geohring. 2001. Fate of N fertilizer and green manure in clay loam and loamy sand soils: I Calibration of the LEACHM model. Plant and Soil 229(1): 57-70.
- Sogbedji, J.M., and H.M. van Es. 2001. Fate of N fertilizer and green manure in clay loam and loamy and soils: II Validation of the LEACHM model. Plant and Soil 229(1): 71-82
- Sogbedji, J.M., H.M. van Es and K.M. Agbeko. 2006. Modeling Nitrogen Dynamics under Maize in Ferralsols in Western Africa. Nutrient Cycling in Agroecosystems. 74:99-113.
- Sogbedji, J.M., H.M. van Es, S.D. Klausner, D.R. Bouldin, and W.J. Cox. 2001. Spatial and temporal processes affecting nitrogen availability at the landscape scale. Soil & Tillage Research 58 (3-4) 233-244.

Manure

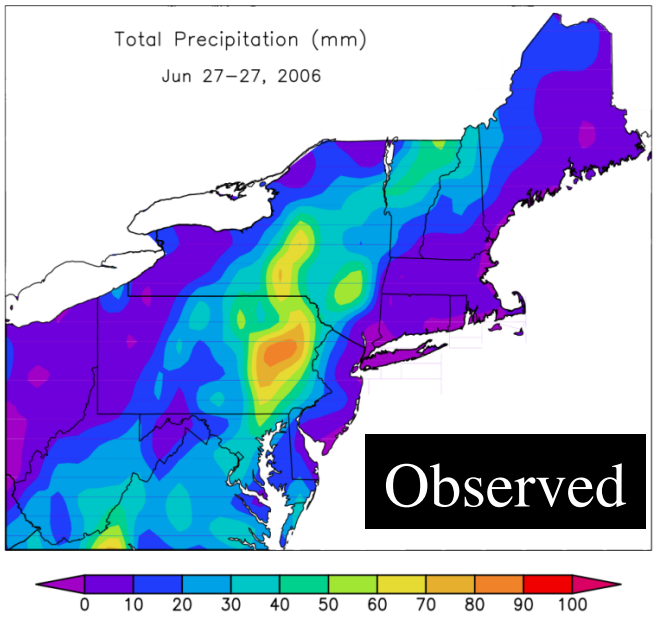
- Sogbedji, J.M., H.M. van Es, J.M. Melkonian, and R.R. Schindelbeck. 2006. Evaluation of the PNM model for simulating drain flow nitrate-N concentrations under manure-fertilized maize. Plant and Soil 282: 343-360.

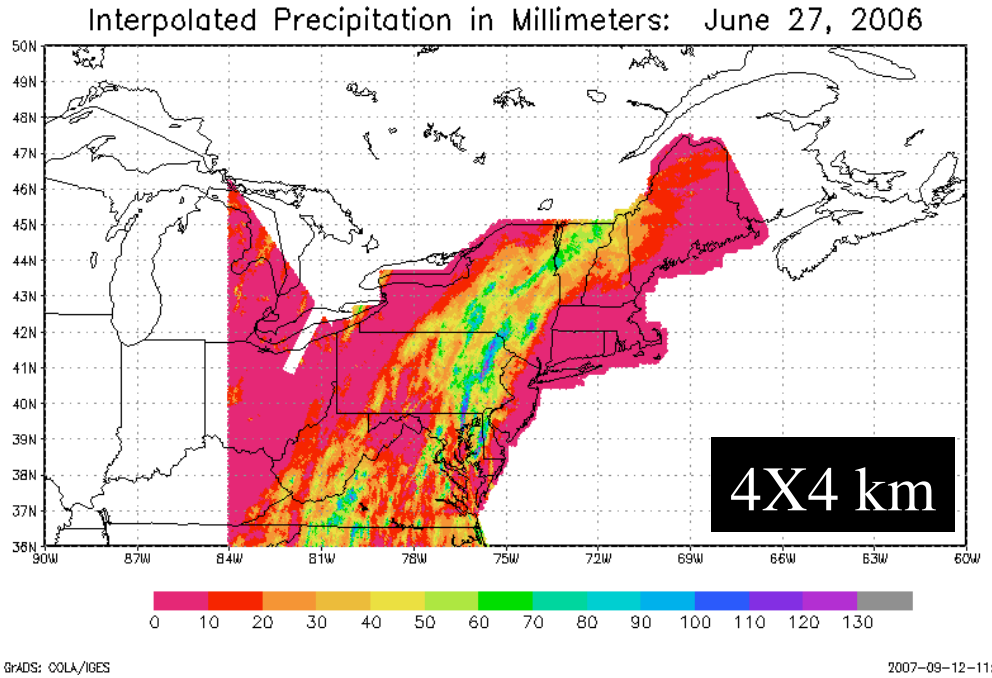
Adapt-N Input:

High Resolution Precipitation Data

Error-Corrected Radar Estimates

Northeast Region Climate Center



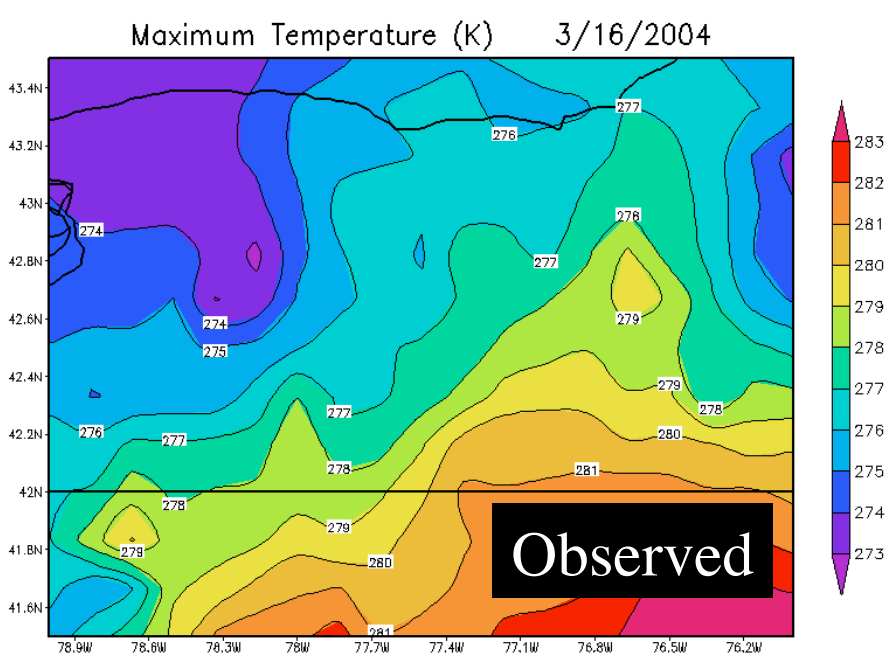


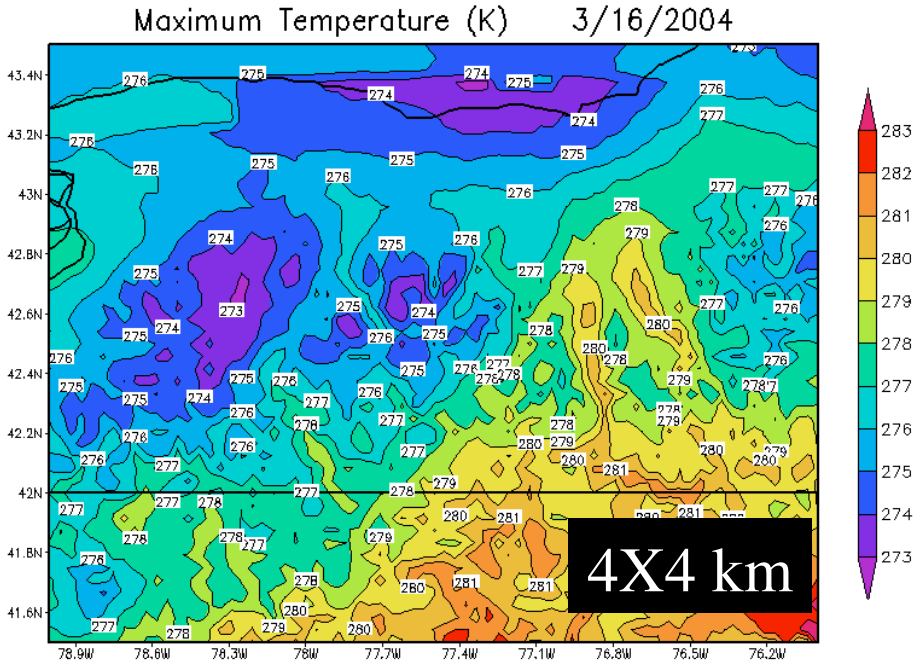
Adapt-N Input:

High Resolution Temperature Data

Elevation-Corrected Spatial Interpolations

Northeast Region Climate Center





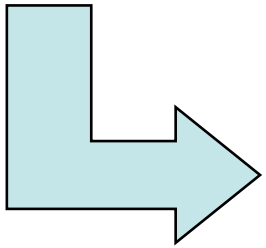
Adapt-N: Information needed

Soil/Tillage

- User ID / Field ID
- Latitude / Longitude
- Soil textural group
- Approximate field slope
- Drainage
- Soil test information
- Tillage information

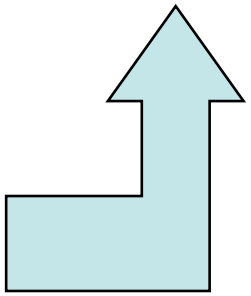
Fertilizer/Crop

- Starter fertilizer
  - type/rate/application date
- Additional fertilizer
- Cultivar maturity class
- Planting date
- Expected harvest population



Organic Inputs

- Manure applications:
  - Two previous years / current year
- Previous sod crop
- 1st year corn after soybean?



Adapt-N Web access:

http://adapt-n.eas.cornell.edu/

Adaptive Nitrogen Management - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://adapt-n.eas.cornell.edu/

mozilla.org mozillaZine mozdev.org

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Climate Center

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Center for Advanced Computing

start entering data

Adapt-N

A tool for calculating corn sidedress nitrogen rates

Begin

What's Adapt-N Used For? | What Info Do I Need? | How Do I Use Adapt-N?

- Provide in-season N recommendations for corn production based on simple soils, management and crop inputs.
- Key feature: accounts for changes in soil N due to early season weather and adjusts the in-season N recommendations accordingly.

Background Info

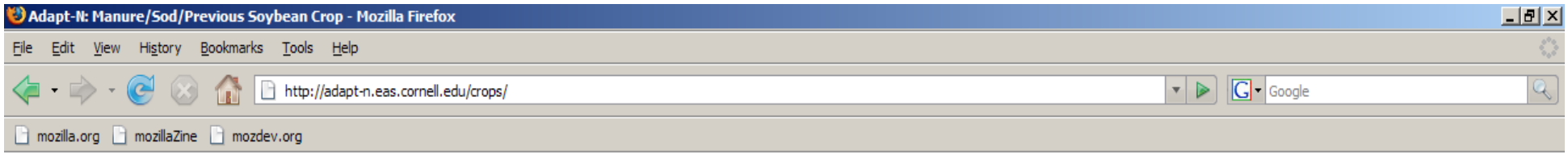
Funded by the Computational Agriculture Initiative

information on determining the latitude and longitude and a summary of the soils, management and crop data required by *Adapt-N.*

quick start instructions to use *Adapt-N* and detailed instructions

http://www.news.cornell.edu/stories/May08/biddy.wisc.html

Start | Eudora | Microsoft PowerPoint - [... | Adaptive Nitrogen Ma... | 8:55 AM



Adapt-N ***A tool for calculating corn sidedress nitrogen rates***

Log In Page

establish a new id or add a new location to your existing id

Please enter user name and field name.

User Name Jeff Field Id East F1

Please enter the latitude and longitude coordinates of the field.

latitude *(for example 42.47)* 41.55 longitude *(for example 76.45)* 75.44

When you've entered all your information, please click the submit button Submit When Complete

User Name and Field ID

Enter latitude and longitude to the hundreths place (0.00).

Click here when you have entered User name, Field ID and latitude and longitude. You will then go to the Main Input page.

Adapt-N *Soil/Tillage System Information*

Soil Information

Please select a soil texture class that best describes the soil in the field. medium: (silt loams)

Please select the approximate slope (%) of the field. less than 3%

Please select a drainage class for the field naturally well-drained or tile-drained

*Was there a **preplant** soil test?* There was a soil test in 2008

If you know the sample depth, please enter it in inches.
Otherwise, please enter 6 inches. *(inches)* 6

soil organic matter: *(%)* 6

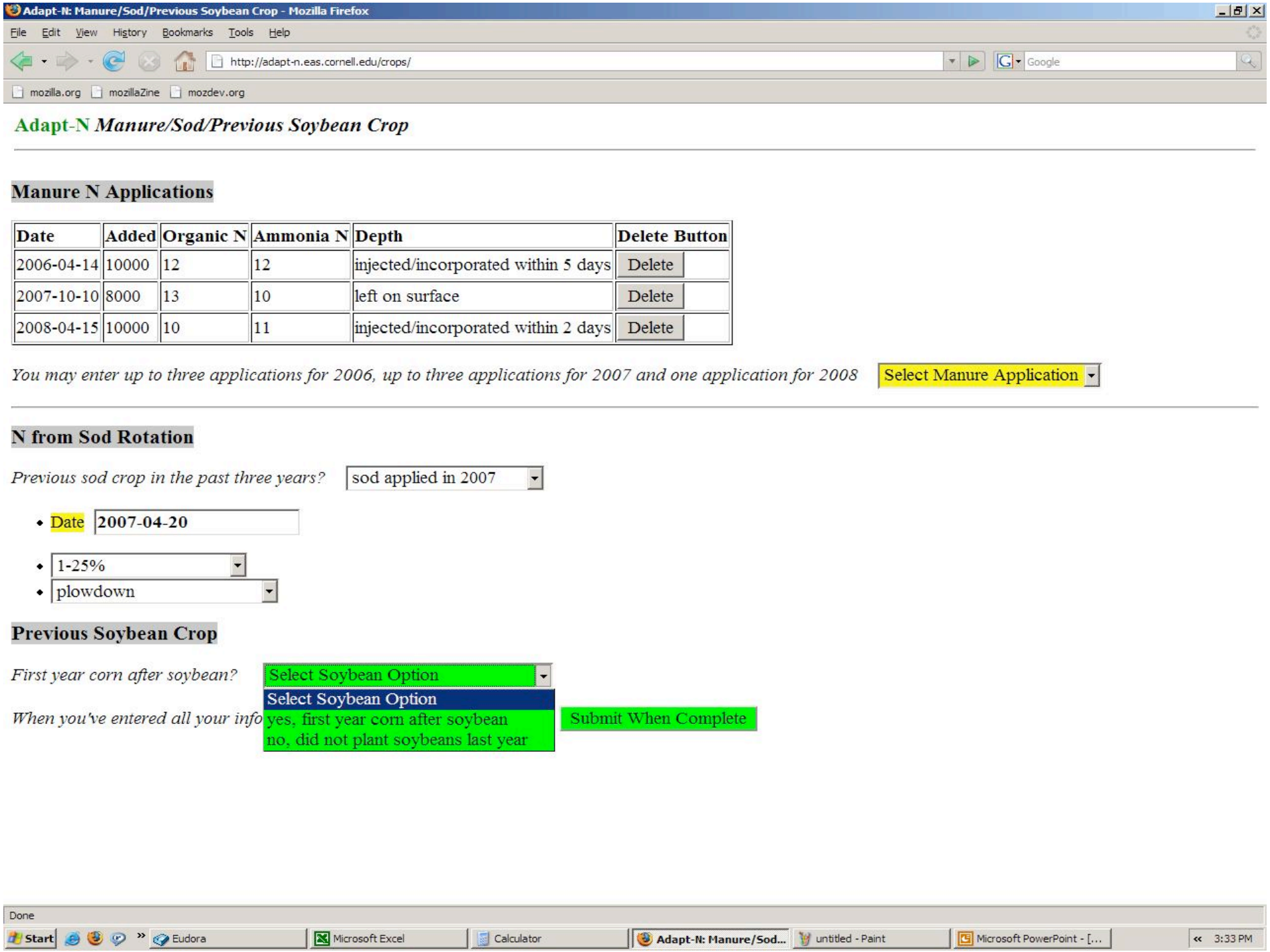
nitrate-N, if available: *(lbs/acre)* 20 collection date if before planting date: **2008-04-08**

Tillage System Information

Please select the tillage system for this field. tillage (plow till, chisel till, disk till

Approximate Date **2008-04-15** Approximate Depth of Primary Tillage *(inches)* 8

When you've entered all your information, please click the submit button Submit When Complete


Adapt-N: Manure/Sod/Previous Soybean Crop - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://adapt-n.eas.cornell.edu/crops/
Google
mozilla.org mozillaZine mozdev.org
Adapt-N Manure/Sod/Previous Soybean Crop
Manure N Applications
Date Added Organic N Ammonia N Depth Delete Button
2006-04-14 10000 12 12 injected/incorporated within 5 days Delete
2007-10-10 8000 13 10 left on surface Delete
2008-04-15 10000 10 11 injected/incorporated within 2 days Delete
You may enter up to three applications for 2006, up to three applications for 2007 and one application for 2008
Select Manure Application
N from Sod Rotation
Previous sod crop in the past three years?
sod applied in 2007
Date 2007-04-20
1-25%
plowdown
Previous Soybean Crop
First year corn after soybean?
Select Soybean Option
Select Soybean Option
yes, first year corn after soybean
no, did not plant soybeans last year
When you've entered all your info
Submit When Complete
Done
Start
Eudora
Microsoft Excel
Calculator
Adapt-N: Manure/Sod...
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Microsoft PowerPoint - [...
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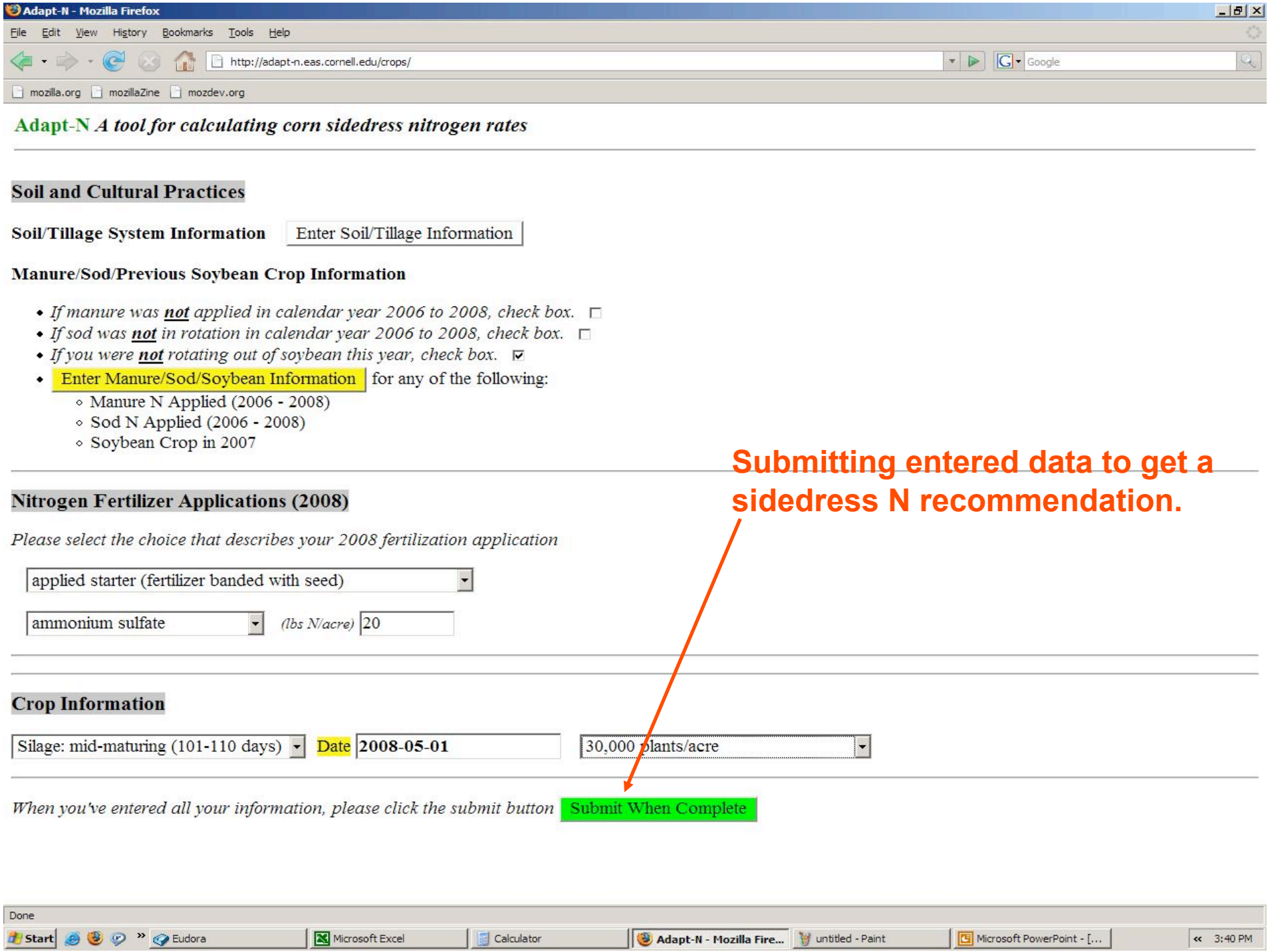
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File Edit View History Bookmarks Tools Help
http://adapt-n.eas.cornell.edu/crops/
mozilla.org mozillaZine mozdev.org
Adapt-N A tool for calculating corn sidedress nitrogen rates
Soil and Cultural Practices
Soil/Tillage System Information
Enter Soil/Tillage Information
Manure/Sod/Previous Soybean Crop Information
If manure was not applied in calendar year 2006 to 2008, check box.
If sod was not in rotation in calendar year 2006 to 2008, check box.
If you were not rotating out of soybean this year, check box.
Enter Manure/Sod/Soybean Information for any of the following:
Manure N Applied (2006 - 2008)
Sod N Applied (2006 - 2008)
Soybean Crop in 2007
Nitrogen Fertilizer Applications (2008)
Please select the choice that describes your 2008 fertilization application
applied starter (fertilizer banded with seed)
ammonium sulfate
(lbs N/acre)
20
Crop Information
Silage: mid-maturing (101-110 days)
Date
2008-05-01
30,000 plants/acre
When you've entered all your information, please click the submit button
Submit When Complete
Submitting entered data to get a sidedress N recommendation.
Done
Start
Eudora
Microsoft Excel
Calculator
Adapt-N - Mozilla Fire...
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Microsoft PowerPoint - [...
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Output

Sidedress N recommendation

Summary Table of User Inputs

Simulation results (weather, soil N and crop N)

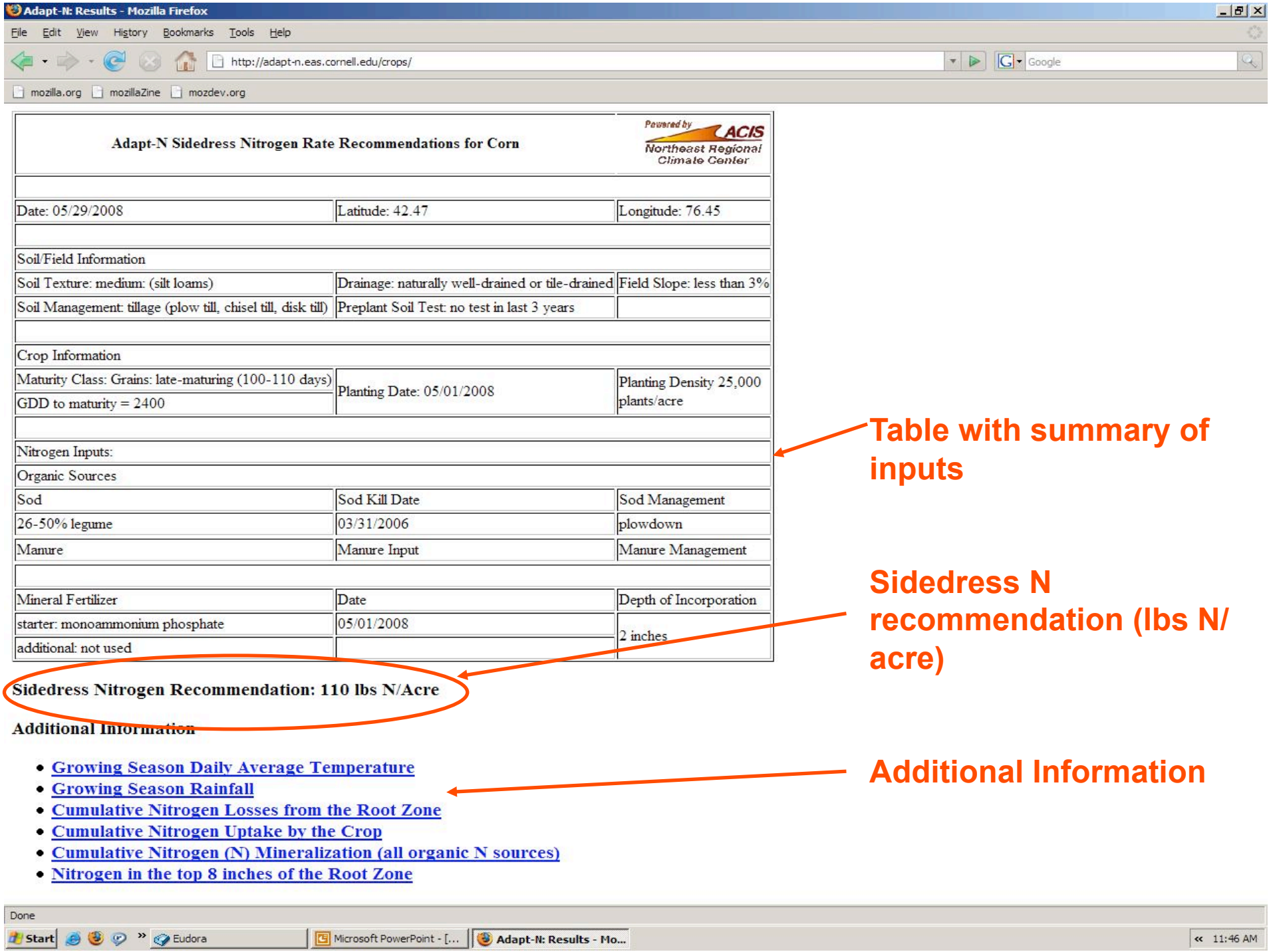
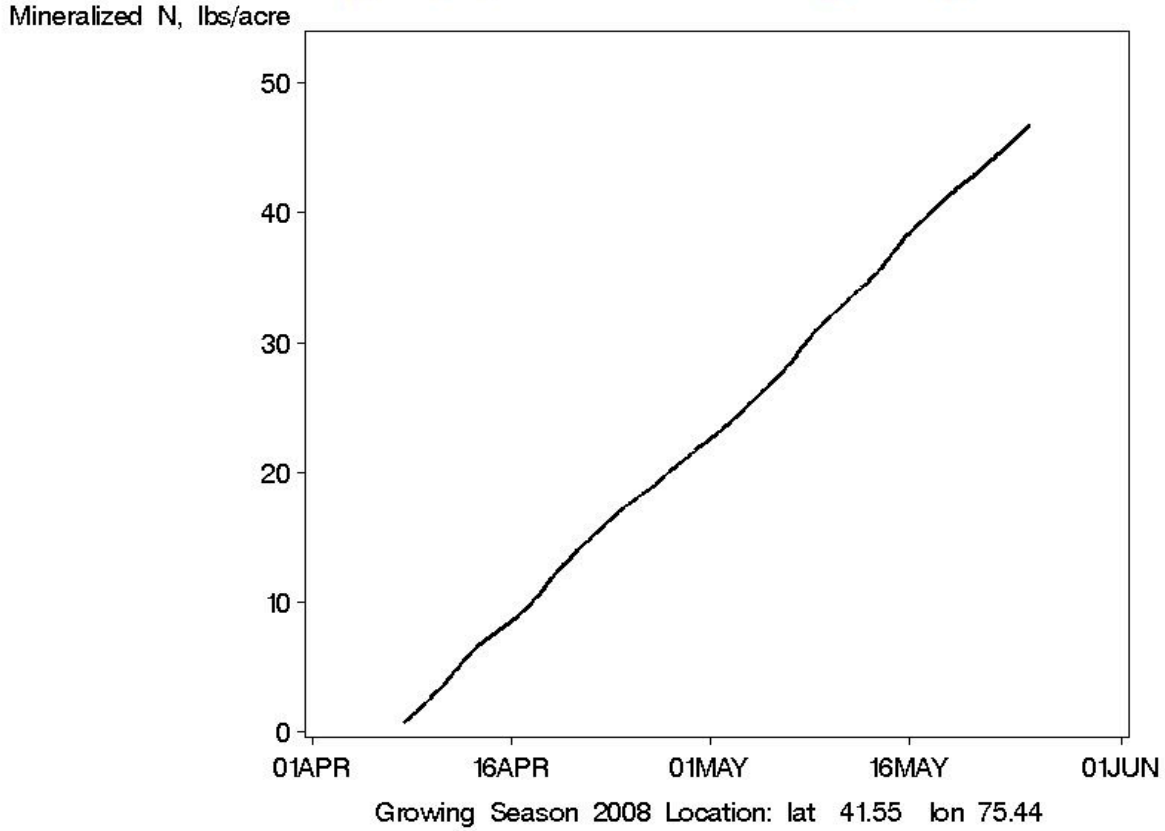


Table with summary of inputs

Sidedress N recommendation (lbs N/ acre)

Additional Information

Cumulative Nitrogen (N) Mineralization (all organic N sources)



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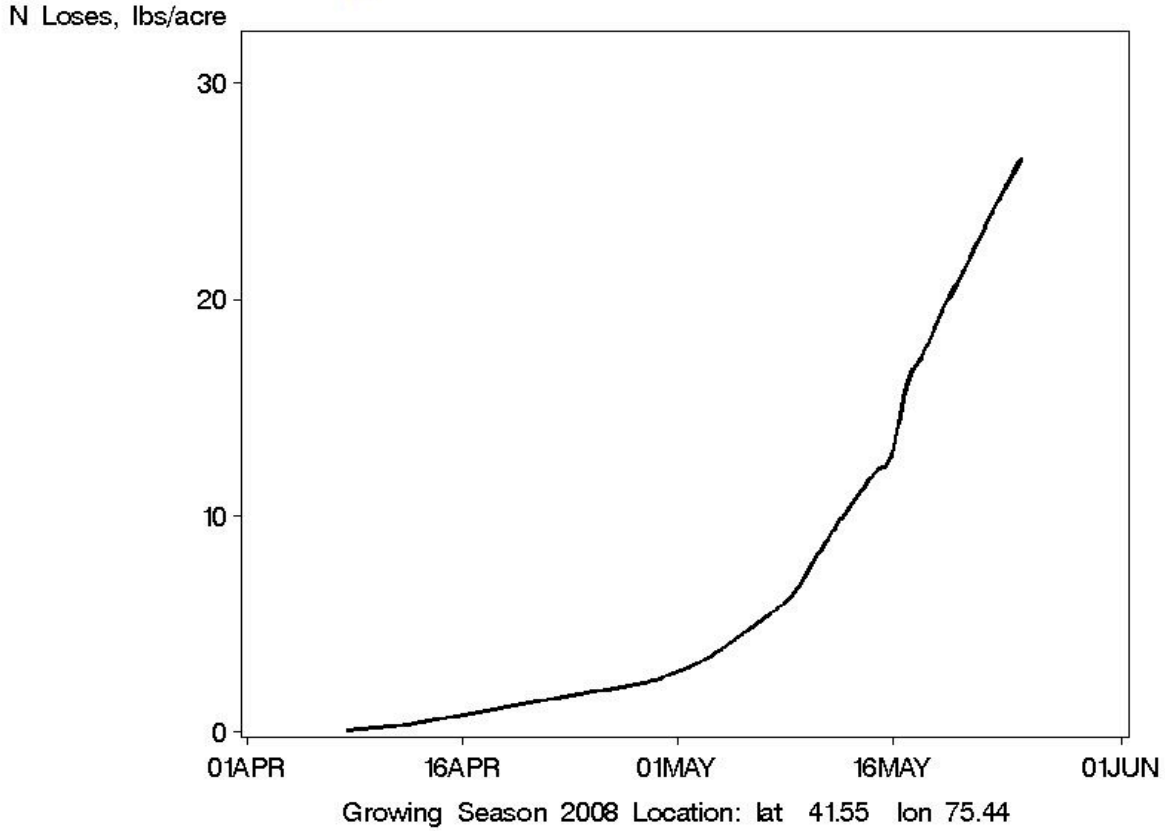
Cumulative Nitrogen Losses From the Root Zone



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Example Strategies of Adaptive N Management

Corn-after-soybean; no organic inputs

1. Starter + sidedress:

20 kg ha^{-1} pre-plant + (based on Adapt-N estimates):

- dry year: +40 kg ha^{-1} sidedress, or none
- normal year: + 80 kg ha^{-1} sidedress
- wet year: + 140 kg ha^{-1} sidedress

2. Pre-planting or at-planting application + incidental sidedress:

80 kg ha^{-1} pre-plant (ideally ammoniacal, controlled release or w/ inhibitor) + (based on Adapt-N estimates)

- dry or normal year: no sidedress
- wet year: +60-80 kg ha^{-1} sidedress

Examples Strategies of Adaptive N Management

Corn-after-corn; with conservative manure inputs

Starter + sidedress: 20 kg ha^{-1} at planting, or none + (based on Adapt-N estimates):

- dry or normal year: no sidedresss
- wet year: +60 kg ha^{-1} sidedress

Conclusions

- Corn N dynamics are strongly affected by interacting weather and soil factors
- Adaptive N management in humid regions allows for increased precision in N management and reductions in N losses
- Ideally, adaptive N management tools are combined with post-season tests to evaluate performance.